

84. A coke according to claim 81 wherein said coke has sodium present in an amount less than about 25 ppm by weight.

85. A process according to claim 1 wherein said thermal cracking process includes adding predetermined hydrocarbon compounds to promote an increase of the VCM content of said coke product to within the range of from about 13% to about 50% by weight.

86. A process according to claim 1 further comprising adding predetermined hydrocarbon compounds to said coke precursor material to promote an increase of the VCM content of said coke product to within the range of from about 13% to about 50% by weight.

87. A process according to claim 1 further comprising adding predetermined hydrocarbon compounds to said coke precursor material which are adapted to decompose at predetermined temperatures to promote the production of sponge coke during said thermal cracking process to within the range of about 40% to 100% by weight of said coke product.

REMARKS

The above changes correspond to changes that were made and accepted in corresponding U.S. Patent Application No. 09/137,283. U.S. Patent Application No. 09/137,283 was recently allowed. The changes do not add new matter or change the substance of the application as it pertains to the claimed invention. The changes serve to correct informalities present in the application as filed and to more clearly describe the invention.

Replacement sheets 4, 36, 99, 104, 105, 118, 119, 130, 143, 144, 147, 149, 166, and 172-184 are different from the originally filed sheets as follows:

(1) Informalities were corrected on page 4, lines 7-10, on page 36, line 6, on page 104, line 8, on page 105, line 17, on page 118, line 24, on page 119, line 13, on page 143, line 3, and on page 166, line 23;

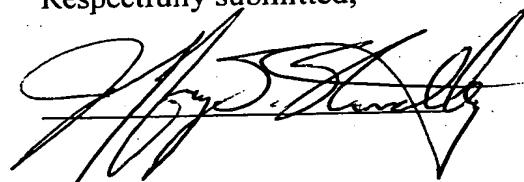
(2) Pages 99, 130, 143-144, 147, and 149 have been amended to correct shifting of the columns in the tables;

(3) Claims 3, 4, 8, and 9 have been canceled without prejudice;

(4) Claims 1, 5, 10, 12, and 15 have been replaced by amended claims bearing the same numbers; and

(5) New claims 77-87 have been added.

Respectfully submitted,



Date: 5/2/00

Jeffrey S. Standley
Attorney for the Applicant
Registration No. 34,021
Standley & Gilcrest LLP

EL039916610US		
 EXPRESS MAIL UNITED STATES POSTAL SERVICE™		
ORIGIN (POSTAL USE ONLY)		
PO ZIP Code <i>43016</i>	Day of Delivery <input checked="" type="checkbox"/> Next <input type="checkbox"/> Second	Flat Rate Envelope <input type="checkbox"/>
Date In <i>5/2/00</i>	Postage <i>\$ 11.75</i>	
Mo. <input checked="" type="checkbox"/> Day <input type="checkbox"/> Year	<input type="checkbox"/> 12 Noon <input type="checkbox"/> 3 PM	Return Receipt Fee
Time In <i>5/2</i>	Military <input type="checkbox"/> AM <input checked="" type="checkbox"/> PM	
Weight <i>8 lbs</i>	<input type="checkbox"/> 2nd Day <input type="checkbox"/> 3rd Day	COD Fee <input type="checkbox"/> Insurance Fee <input type="checkbox"/>
No Delivery <input type="checkbox"/> Weekend <input type="checkbox"/> Holiday	Int'l Alpha Country Code <i>SB</i>	Total Postage & Fees <i>\$ 11.75</i>
CUSTOMER USE ONLY		
METHOD OF PAYMENT Express Mail Corporate Acct. No. <i>X4301221298002</i>		
<input type="checkbox"/> WAIVER OF SIGNATURE (Domestic Only): Additional merchandise insurance is void if waiver of signature is requested. I wish delivery to be made without obtaining signature of addressee or addressee's agent. If delivery employee judges that article can be left in secure location and I authorize that delivery, employee's signature constitutes valid proof of delivery.		
<input type="checkbox"/> NO DELIVERY <input type="checkbox"/> Weekend <input type="checkbox"/> Holiday		
Customer Signature <i>Jeffrey S. Standley</i>		
FROM: (PLEASE PRINT) <i>STANLEY & GILCREST</i> 495 METRO PL S STE 210 DUBLIN OH 43017-5315	TO: (PLEASE PRINT) <i>Assistant Commissioner for Patents</i> Box PCT WAshington, D.C. 20231	PHONE <i>(614) 792-5555</i>
ENV1298-002C		
PRESS HARD. You are making 3 copies.		
FOR PICKUP OR TRACKING CALL 1-800-222-1811 www.usps.gov 		

lighter). When other operational variables are held constant, the "maximum possible temperature" normally minimizes the volatile material remaining in the petroleum coke by-product. In delayed coking, the lower limit of volatile material in the petroleum coke is usually determined by the coke hardness. That is, petroleum coke with < 8 wt. % volatile materials is normally so hard that the drilling time in the decoking cycle is extended beyond reason. Various petroleum coke uses have specifications that require the volatile content of the petroleum coke by-product be < 12%. Consequently, the volatile material in the petroleum coke by-product typically has a target range of 8-12 wt. %. Prior art in the delayed coking process, including recent developments, has attempted to maximize the production of cracked liquids with less coke production. In this manner, the prior art of delayed coking has attempted to minimize coke yield and the amount of volatile materials it contains.

Fluid Coking^R, developed since the late 1950s, is a continuous coking process that uses fluidized solids to increase the conversion of coking feedstocks to cracked liquids, and further reduce the volatile content of the product coke. In Fluid Coking^R, the coking feedstock blend is sprayed into a fluidized bed of hot, fine coke particles in the reactor. Since the heat for the endothermic cracking reactions is supplied locally by these hot particles, this permits the cracking and coking reactions to be conducted at higher temperatures (about 480-565 °C or 900-1050 °F) and shorter contact times than in delayed coking. Roughly 15-25% of the coke is burned in an adjacent burner vessel in order to create the hot coke nuclei to contact the feed in the reactor vessel, and satisfy the process heat requirements. The Fluid Coking^R technology effectively removes the lower limit of volatile content in the petroleum coke, associated with delayed coking. The volatile content of the petroleum coke produced by the Fluid Coking^R technology is typically minimized (or reduced), within the range of 4-10 wt %. Consequently, the quantity of petroleum coke, produced by a given feedstock, and its volatile content are significantly reduced in the Fluid Coking^R technology (vs. delayed coking).

As noted above, many operational variables *indirectly* affect the coke VCM. As such, the selection of the appropriate modifications in the delayed coker operating conditions is not straightforward. In many cases, changes in the feedstock gravity and reductions in coker cycle time tend to increase the coke VCM, but provides limited change in VCM quality. Increases in drum pressure tend to increase the quality and quantity of coke VCM, but can be difficult to control coke VCM within a narrow target range. The reduced steam stripping in the decoking cycle has been noted to have limited effect on coke VCM content. However, reduced coke drum temperatures tend to increase and maintain both the quality and quantity of coke VCM. Reduced coke drum temperatures can decrease the cracking reactions, increasing unreacted feedstock and partially cracked components. In most cases, it provides a lower vaporization temperature in the coke drum, leaving lighter cracked or unreacted hydrocarbon components (i.e. higher quality VCM) integrated in the coke. In addition, the coke VCM content can be more predictable via reduced drum temperatures (vs. other operational variables). As such, coke VCM content can be readily controlled within a specified range. Furthermore, reduced coke drum temperatures have the added benefit of improving the coke crystalline structure (See below). Consequently, reduced coke drum temperatures was selected as the preferred means of increasing coke VCM to achieve the objectives of the present invention.

Based on this analysis, the simplest and preferred means of increasing and maintaining the volatile content of the coke (i.e. to a consistent level between 13 and 50 wt. % VCM) would result from a reduction of the average drum temperature by 5-25 80 °F (preferably 5-40 °F). That is, an average drum vapor line temperature of 770 to 850 °F can provide VCM levels of 15-30% for many coker feedstocks. However, as noted earlier, coker feedstocks vary considerably among refineries, and can attain 15-30% VCM outside of this temperature range. In these situations, the relative temperature drop from the existing average drum temperature is expected to be

Basis = 1.0×10^9 Btu/Hr Heat Release Rate as Input

<u>Fuel Characteristics</u>		<u>Current Coal</u>	<u>Upgraded coke</u>	
<u>Results</u>				
	VCM (%wt)	40.0	16.0	60%
Lower	Ash (%wt.)	9.1	0.3	97%
	Lower Moisture (%wt.)	3.6	0.3	92%
	Lower Sulfur (%wt)	4.0	4.3	8%
	Higher Heating Value (MBtu/lb)	12.9	15.3	19%
Higher	Fuel Rate (Mlb/Hr)	77.8	65.4	16%
Lower				

Pollutant Emissions: Uncontrolled/Controlled

Ash Particulates (lb/MMBtu or Mlb/Hr)	7.1/0.4	0.2/.01	97%
Lower			
Sulfur Oxides (lb/MMBtu or Mlb/Hr)	6.2/6.2	5.6/.6	90%
Lower			
Carbon Dioxide (lb/MMBtu or Mlb/Hr)	238	210	12%
Lower			

This example demonstrates major benefits from the application of the present invention. The upgraded petroleum coke has substantially lower ash and moisture contents, compared to the existing coal. These factors contribute greatly to (1) the ability to burn successfully with lower VCM and (2) a fuel heating value that is 19% higher. In turn, the higher heating value requires a 16% lower fuel rate to achieve the heat release rate basis of one billion Btu per hour in the boiler. As noted previously, this lower fuel rate and the softer sponge coke significantly reduce the load and wear on the fuel processing system, while increasing the pulverizer efficiency and improving combustion characteristics.

The ash particulate emissions (ash from the fuel) are 97% lower than the existing coal, due to the lower ash content and higher fuel heating value. In this manner, fuel switching to the upgraded coke unleashes 97% of the capacity in the

operating conditions for a particular coker feedstock blend and particular product specifications for the downstream processing requirements. The series of pilot plant studies are typically designed to produce empirical data for operating conditions with variations in feedstock blends and liquid product specification requirements. Consequently, the fluid coker designs and target operating conditions vary significantly among refineries.

In normal fluid coker operations, various operational variables are monitored and controlled to achieve the desired fluid coker operation. The primary operational variables that affect coke product quality in the fluid coker are the reactor temperature, reactor residence time, and reactor pressure. The reactor temperature is controlled by regulating (1) the temperature and quantity of coke recirculated from the burner to the reactor and (2) the feed temperature, to a limited extent. The temperature of the recirculated coke fines is controlled by the burner temperature. In turn, the burner temperature is controlled by the air rate to the burner. The reactor residence time (i.e. for cracking and coking reactions) is essentially the holdup time of fluidized coke particles in the reactor. Thus, the reactor residence time is controlled by regulating the flow and levels of fluidized coke particles in the reactor and burner. The reactor pressure normally floats on the gas compressor suction with commensurate pressure drop of the intermediate components. The burner pressure is set by the unit pressure balance required for proper coke circulation. It is normally controlled at a fixed differential pressure relative to the reactor. The following target control ranges are normally maintained in the fluid coker for these primary operating variables:

1. Reactor temperatures in the range of about 950 °F to about 1050°F,
2. Reactor residence time in the range of 15-30 seconds
3. Reactor pressure in the range of about 0 psig to 100 psig: typically 0-5 psig,
4. Burner Temperature: typically 100-200 °F above the reactor temperature

These traditional operating variables have primarily been used to control the quality of the cracked liquids and various yields of products, but *not* the respective quality of the byproduct petroleum coke.

C. Process Control of the Present invention:

The primary improvements of the present invention are modifications to the operating conditions of the Fluid Coking^R process, in a manner that is not suggested by prior art. In fact, these changes in operating conditions are contradictory to the teachings and current trends in the prior art. As noted previously, the operating conditions of the prior art give first priority to maximizing cracked liquid products. The operating conditions of the present invention give first priority to consistently increasing the volatile combustible material in the resulting petroleum coke to 13-50 wt. % VCM (preferably 15-30% VCM). Second priority is given to consistently provide a minimum-acceptable level of coke crystalline structure in the product coke. The third priority is THEN given to maximize coker throughput and/or the conversion of coker feedstock blend to cracked liquid products. However, changing the VCM content and crystalline structure in fluid coke is much more challenging, relative to delayed coke. The operating conditions required to achieve the objectives of the present invention were moderate, yet specific changes relative to the prior art.

As discussed previously, fluid coker operating conditions vary greatly among refineries, due to various coker feedstocks, coker designs, and other refinery operations. Therefore, specific operating conditions (i.e. absolute values) for various refinery applications are not possible for the present invention. However, specific changes relative to existing operating conditions provide specific methods of operational change to achieve the desired objectives

INCREASED VOLATILE COMBUSTIBLE MATERIAL (VCM) IN FLUID^R COKE: In a manner similar to the delayed coking process, reduction in the process operating temperature will cause an increase of volatile combustible material in the resulting petroleum coke. That is, the reduction in process (or reactor) temperature will reduce the cracking and coking reactions, and thereby, leaving more unreacted coker feedstock and cracked liquids in the coke as volatile combustible material. However, the different mechanism of coking in the

engineered solutions to treat the coke after the coking process. Options for this embodiment might include various physical, chemical, and/or biological treatments. Another option may also use the transportation and storage of the coke to increase treatment time. This option may require final treatment steps, rinsing, and water treatment systems at the coke user's facility.

COKER FEEDSTOCK DILUTION: Another embodiment of the present invention would modify the coker feedstocks to reduce the concentration of contaminants in the final coke product. Coke-producing feedstocks with lower concentrations of the contaminants of concern would be added to the coker feed to dilute the concentration of contaminants in the petroleum coke product.

COKER FEEDSTOCK PRETREATMENT: Yet another embodiment of the present invention may include other types of coker feedstock pretreatment. From a technical perspective, the addition of a coker feed pretreatment system would likely be the most effective means of addressing the detrimental impacts of petroleum coke contaminants. However, this embodiment often is not economically optimal. The optimal coker feed treatment system would depend on the composition of the coker feedstocks and the needs of the petroleum coke user. After the degree of required decontamination and the impacts of feed treatment decontamination are known, various engineered solutions would be available to treat the coker feedstocks. This coker feed treatment system may or may not include more sophisticated demetallization and/or desulfurization technologies, described in the prior art. For example, hydrotreating or hydrodesulfurization of the coker feedstocks can decrease the sulfur content by 80-95%. If most of the sulfur is removed from the product coke in this manner, the excess capacity of in a utility boiler's existing particulate control device can be used for the collection of other gases (e.g. carbon dioxide) that are converted to collectible particulates. Also, desulfurization of the coker feedstock may provide further advantage by increasing coke VCM and promoting sponge coke.

CURRENT REFINERY OPERATION WITH NO FURTHER DECONTAMINATION:

Another embodiment of the present invention may include no treatment of any kind for decontamination of the coke. As noted previously, the effects of petroleum coke's high metals content in combustion and heat transfer equipment is not well understood or defined. The design and operation of the user's combustion system plays a major role in determining whether the current level of contaminants in the coke is acceptable or not. Therefore, some oil refineries, depending on the coker feedstock blend and coker operation, may be able to provide the upgraded petroleum coke without further coke decontamination.

GENERAL ISSUES FOR EMBODIMENTS OF LOW-LEVEL

DECONTAMINATION: After the specific level of required coke decontamination is determined for any given product coke, engineering will determine the optimal use for any of the above embodiments, separately or in combination. The combination of any of these embodiments may reduce the level of decontamination required by each embodiment, individually. Finally, these concepts and embodiments may be applied to other types of coking and desalting processes, available now or in the future.

3. Production of Premium "Fuel-Grade" Petroleum Coke: *Optimized Fuel Embodiment*

The various methods and embodiments of the present invention can also be used to optimize combustion characteristics for specific combustion applications. The following embodiment provides a means to produce an upgraded petroleum coke that not only achieves the basic objectives of this invention, but also optimizes fuel characteristics to replace existing solid fuels with the least (or lower) amount of equipment and operational modifications. As noted earlier, one fuel can be directly substituted for an existing fuel in a full-scale operation, if the burning characteristics are sufficiently similar. As such, the various techniques, used in this invention to create a premium petroleum coke, can be optimized in many cases to produce a direct replacement fuel for existing facilities. In this manner, a specific coker with certain

Basis = 1.0×10^9 Btu/Hr Heat Release Rate as Input

<u>Fuel Characteristics</u>		<u>Current Coal</u>	<u>Upgraded coke</u>	<u>Results</u>
VCM	(%wt)	44.2	20.0	54% Lower
Ash	(%wt.)	10.8	0.3	97% Lower
Moisture	(%wt.)	17.6	3.8	78% Lower
Sulfur	(%wt)	4.3	5.2	21% Higher
Heating Value (Mbtu/lb)		10.3	14.2	38% Higher
Fuel Rate	(Mlb/Hr)	97.0	70.4	27% Lower

Pollutant Emissions: Uncontrolled/Controlled

Ash Particulates	(lb/MMBtu or Mlb/Hr)	10.5/.53	.18/.01	98% Lower
Sulfur Oxides	(lb/MMBtu or Mlb/Hr)	8.4/.84	7.4/.15	82% Lower
Carbon Dioxide	(lb/MMBtu or Mlb/Hr)	245	214	13% Lower

This example further demonstrates the beneficial application of the present invention.

Again, the upgraded petroleum coke has substantially lower ash and moisture contents, compared to the existing coal. These factors contribute greatly to (1) the ability to burn successfully with lower VCM and (2) a fuel heating value that is 38% higher. In turn, the higher heating value requires a 27% lower fuel rate to achieve the heat release rate basis of one billion Btu per hour in the boiler. As noted previously, this lower fuel rate and the softer sponge coke significantly reduce the load and wear on the fuel processing system, while increasing pulverizer efficiency and improving combustion properties.

The ash particulate emissions (ash from the fuel) are 98% lower than the existing coal, due to the lower ash content and higher fuel heating value. Consequently, fuel switching to the upgraded coke unleashes 97% of the capacity in the existing particulate control device. This excess capacity can now be used for the control of sulfur oxides via retrofit FGC

applications. The present invention anticipates effective integration of this technology. Similar to the previous embodiment, the upgraded coke of the present invention has many desirable characteristics of the activated carbon. In many cases, the upgraded coke can be readily modified to be effectively used as the activated coke. Again, the coke loses activation after numerous cycles of use and regeneration. Apparently, this occurs more quickly in the high-sulfur applications. Deactivated coke can then be blended into coke fuel and subsequently burned in the combustion system.

In a similar manner, the upgraded coke of the present invention can be used for activated carbon technologies for the removal of air toxics (e.g. mercury), carbon dioxide, or other undesirable flue gas components. The activated carbon technologies for these components system can be integrated (1) fully into the SO_x/NO_x activated coke system (to the extent possible), (2) share auxiliary systems, or (3) work independently with or without the SO_x/NO_x activated coke system. In any case, deactivated coke can be blended into the coke fuel and subsequently burned in the combustion system.

E. EXAMPLE 3: Low-Sulfur Lignite Coal vs. Medium Sulfur Coke with Dry Sorbent Injection

Another power utility has a conventional, pulverized-coal fired utility boiler that currently burns a low-sulfur, lignite coal from Texas. The existing utility has a large-capacity, particulate control device with no sulfur oxides control. Full replacement of this coal with a medium-sulfur, petroleum coke produced by the present invention would have the following results:

Basis = 1.0×10^9 Btu/Hr Heat Release Rate as Input

<u>Fuel Characteristics</u>		<u>Current Coal</u>	<u>Upgraded coke</u>	<u>Results</u>
VCM	(%wt)	31.5	16.0	49%
Lower				
Ash	(%wt.)	50.4	0.3	99+%
Lower				

Heating Value (Mbtu/lb)	3.9	15.3	290% Higher
Fuel Rate (Mlb/Hr)	254	65.4	74% Lower

Pollutant Emissions: Uncontrolled/Controlled

Ash Particulates (lb/MMBtu or Mlb/Hr)	128/6.4	0.2/.01	99+% Lower
Sulfur Oxides (lb/MMBtu or Mlb/Hr)	5.1	3.2/.96	37/81% Lower
Carbon Dioxide (lb/MMBtu or Mlb/Hr)	315	210/150	33/52% Lower

This example further demonstrates the beneficial application of the present invention. Again, the upgraded petroleum coke has substantially lower ash and moisture contents, compared to the existing coal. These factors contribute greatly to (1) the ability to burn successfully with lower VCM and (2) a fuel heating value that is 290% higher. In turn, the higher heating value requires a 74% lower fuel rate to achieve the heat release rate basis of one billion Btu per hour in the boiler. As noted previously, this lower fuel rate and the softer sponge coke substantially reduce the load and wear on the fuel processing system, while increasing the pulverizer efficiency and improving combustion characteristics.

The ash particulate emissions (ash from the fuel) are >99+% lower than the existing coal, due to the lower ash content and higher fuel heating value. Consequently, fuel switching to the upgraded coke unleashes >99% of the capacity in the large, existing particulate control device. Part of this excess capacity can now be used for the control of sulfur oxides via retrofit SOx FGC technology.

In this example, dry sorbent injection into the combustion system with the excess capacity of the existing PCD is sufficient to achieve the desirable sulfur oxides control. Dry

Basis = 1.0×10^9 Btu/Hr Heat Release Rate as Input

<u>Fuel Characteristics</u>		<u>Current Coal</u>	<u>Upgraded coke</u>	<u>Results</u>
VCM	(%wt)	40.8	16.0	61% Lower
Ash	(%wt.)	5.2	0.3	94% Lower
Moisture	(%wt.)	23.4	0.3	99% Lower
Sulfur	(%wt)	0.44	0.65	48% Higher
Heating Value (Mbtu/lb)		9.5	15.3	61% Higher
Fuel Rate	(Mlb/Hr)	105	65.4	38% Lower

<u>Pollutant Emissions: Uncontrolled/Controlled</u>				
Ash Particulates	(lb/MMBtu or Mlb/Hr)	5.5/.3	0.2/.01	97% Lower
Sulfur Oxides	(lb/MMBtu or Mlb/Hr)	0.92	0.85	8% Lower
Carbon Dioxide	(lb/MMBtu or Mlb/Hr)	277	210/190	23/31% Lower

This example further demonstrates the beneficial application of the present invention. Again, the upgraded petroleum coke has substantially lower ash and moisture contents, compared to the existing coal. These factors contribute greatly to (1) the ability to burn successfully with lower VCM and (2) a fuel heating value that is 61% higher. In turn, the higher heating value requires a 37% lower fuel rate to achieve the heat release rate basis of one billion Btu per hour in the boiler. As noted previously, this lower fuel rate and the softer sponge coke substantially reduce the load and wear on the fuel processing system, while increasing the pulverizer efficiency and improving combustion characteristics.

In this example, the desulfurized petroleum coke of the present invention is sufficient to achieve very low sulfur oxide emissions (<1.25 lb/MMBtu). In fact, the desulfurized coke achieves 8% lower emissions (i.e. .85 vs. .92 lb/MMBtu) than this very low sulfur, western coal, even though the desulfurized coke has 50% higher sulfur content. Consequently, the

emissions control. Replacement of half of this coal (i.e. 50% by weight) with a high-sulfur petroleum coke produced by the present invention would have the following results:

Basis = 1.0×10^9 Btu/Hr Heat Release Rate as Input

<u>Fuel Characteristics</u>		<u>Current Coal</u>	<u>50/50 Coal/Coke</u>	<u>Results</u>
VCM	(%wt)	40.2	28.1	32% Lower
Ash	(%wt.)	9.1	4.7	48% Lower
Moisture	(%wt.)	5.2	2.8	46% Lower
Sulfur	(%wt)	2.3	3.3	43% Higher
Heating Value (Mbtu/lb)		12.5	13.9	11% Higher
Fuel Rate	(Mlb/Hr)	79.7	72.6	9% Lower

Pollutant Emissions: Uncontrolled/Controlled

Ash Particulates (lb/MMBtu or Mlb/Hr)	7.3/0.7	3.8/0.4	43% Lower
Sulfur Oxides (lb/MMBtu or Mlb/Hr)	3.7/3.7	4.7/1.4	62% Lower
Carbon Dioxide (lb/MMBtu or Mlb/Hr)	216	210	3% Lower

This example further demonstrates the beneficial application of the present invention. The 50%/50% mixture of the existing coal and upgraded petroleum coke has significantly lower ash and moisture contents, compared to the existing coal. These factors contribute greatly to (1) the ability to burn successfully with lower VCM and (2) a fuel heating value that is 11% higher. In turn, the higher heating value requires a 9% lower fuel rate to achieve the heat release rate basis of one billion Btu per hour in the boiler. As noted previously, this lower fuel rate and the softer sponge coke substantially reduce the load and wear on the fuel processing system, while increasing the pulverizer efficiency and improving combustion characteristics.

The ash particulate emissions (ash from the fuel) are >43% lower than the existing

Another process of the present invention produces modified petroleum coke with adsorbent characteristics (with or without steam activation) that can be effectively used for carbon adsorption in combustion processes. In a manner similar to steam activation, the combustion process itself can potentially activate the unburned coke char and promote carbon adsorption mechanisms in the flue gas. The relative quantity of this adsorption carbon from unburned premium petroleum coke can be adjusted by controlling the fuel blend, pulverization fineness, excess air, and/or other parameters of the combustion process. Alternatively, other activated carbon (e.g. see above paragraph) can be added to the fuel or the flue gas to provide higher concentration of activated carbon in the flue gas. In this manner, the unburned premium petroleum coke and/or used adsorption carbon from the present invention can adsorb mercury, dioxins, furans, other air toxics, and other undesirable pollutants from the flue gas, including carbon dioxide, SO_x, and NO_x. The presence of sulfur, available in the coke, can enhance the adsorption of mercury, a growing concern of power generation facilities. In this manner, the premium coke can achieve further reduction of environmental emissions from the combustion process.

7. Use of Premium "Fuel-Grade" Petroleum Coke: Optimized Environmental Embodiment:

The various methods and embodiments of the present invention, used to control environmental emissions, can also be used to optimize the overall environmental controls for specific combustion applications. In this manner, an existing combustion facility can be modified to produce the optimal combination of environmental controls to meet or exceed environmental regulations. The following embodiment provides a means (1) to produce an upgraded petroleum coke that not only achieves the basic objectives of this invention, but (2) to also optimize the various environmental control options for various undesirable flue gas components and solid wastes.

CLAIMS

What is claimed is:

1. A process of producing a coke fuel, said method comprising the steps:
 - (a) obtaining a coke precursor material derived from crude oil, and having a volatile organic component; and
 - (b) subjecting said coke precursor material to a thermal cracking process for sufficient time and at sufficient temperature and under sufficient pressure so as to promote the production of sponge coke and to produce a coke product having volatile combustible material (VCM) present in an amount in the range of from about 13% to about 50% by weight;

wherein said coke product is comprised of sponge coke in an amount in the range of about 40% to 100% by weight.
2. A process according to claim 1 wherein said coke precursor material is subjected to an efficient desalting process prior to step (b) and sodium levels are reduced to <15 ppm by weight.
5. A process according to claim 1 wherein said volatile combustible material in said coke product is in the range of from about 15% to about 30% by weight.
6. A coke product made in accordance with a process according to claim 1.

7. A coke product made in accordance with a process according to claim 2.
10. A method for producing energy, said method comprising combusting a fuel, said fuel comprising coke, said coke comprising sponge coke in an amount in the range of about 40% to 100% by weight and having volatile combustible materials in an amount in the range from about 13% to about 50% by weight.
11. A method for producing energy according to claim 10 wherein said volatile combustible materials in said coke is in the range of from about 15% to about 30% by weight.
12. A method for producing energy according to claim 10 wherein said fuel comprises a mixture of said coke and coal, wherein the heat release rate ratio of said coke to said coal in said mixture is greater than about 1:4.
13. A method for producing energy according to claim 10 wherein said fuel consists essentially of coke comprising volatile combustible materials in amount in the range from about 13% to about 50% by weight.
14. A method for producing energy according to claim 10 wherein said fuel consists essentially of coke comprising volatile combustible materials in amount in the range from about 15% to about 30% by weight.
15. A method for removing undesirable flue gas components, said method comprising

(a) injection of conversion reagents with sufficient mixing and sufficient residence time at sufficient temperature to convert undesirable flue gas components to collectible particulates upstream of a particulate control device (PCD) and

(b) collecting said particulates in particulate control device, said particulate control device includes, but is not limited to, a PCD process selected from the group consisting of electrostatic precipitators (dry or wet), filtration, cyclones, and conventional wet scrubbers.

16. A method for removing undesirable flue gas components according to claim 15, wherein unreacted flue gas conversion reagents are recycled to increase reagent utilization, wherein said recycle rate exceeds 5% by weight of the collected flyash.

17. A method for removing undesirable flue gas components according to claim 15, wherein spent flue gas conversion reagents are regenerated and reused, wherein said regeneration rate exceeds 70% by weight of the collected flyash, and less than 30% of the collected flyash is disposed as a purge (or blowdown) stream, containing high concentration of impurities. Said regeneration method includes, but is not limited to, a process from the group of hydration, precipitation, and other unit operations.

18. A method for removing undesirable flue gas components according to claim 15, wherein purge stream from the regeneration process is used as a resource for valuable metals, wherein said valuable metals are extracted and purified.

19. A process of producing coke, said process comprising the steps:
 - (a) Providing a coke precursor material derived from fossil carbonaceous origin; and
 - (b) Subjecting said coke precursor material to a thermal cracking process for sufficient time and at sufficient temperature and under sufficient pressure so as to produce a coke product having volatile combustible materials (VCMs) present in an amount in the range from about 13% to about 50% by weight.
20. A process according to claim 19 wherein said coke precursor material is derived from crude oil, coal, or tar sands.
21. A process according to claim 19 wherein said VCMs are present in an amount in the range of from about 15% to about 30% by weight.
22. A process according to claim 19 further comprising altering the crystalline structure of said coke product to promote production of essentially sponge coke with sufficient porosity and sufficient physical & chemical properties to provide low to medium grades of adsorption quality carbon.
23. A process according to claim 22 further comprising introducing at least one chemical compound into said thermal cracking process to improve the adsorption characteristics of said coke product.
24. A process according to claim 23 wherein said at least one chemical compound is selected from the group consisting of hydrogen, plastics, wood wastes, coals, and non-volatile hydrocarbons with appropriate cracking/coking characteristics.

25. A process according to claim 22 wherein coke adsorption characteristics are used for further coke treatment, said coke treatment including the removal of at least one undesirable chemical compound, said coke treatment comprising the steps:
 - (a) Selective addition of at least one chemical reactant in a fluid that passes through said coke; and
 - (b) Maintaining sufficient temperature, sufficient pressure, and sufficient residence time to cause a reaction of desired degree.
26. A process according to claim 25 wherein said at least one undesirable chemical compound is sulfur, nitrogen, or a metal.
27. A process according to claim 25 wherein said fluid is a coke quench medium.
28. A process according to claim 25 further comprising calcining said coke to remove excessive VCMs and alter crystalline structure to low porosity coke with sufficient density such that said coke is adapted to be used for steel or aluminum manufacture.
29. A process according to claim 22 wherein coke adsorption characteristics are used for further coke treatment, said coke treatment including the addition of at least one desirable chemical compound in a fluid that passes through said coke, said at least one desirable chemical compound selected from the group consisting of VCMs, chemical adsorbents, and oxygen-containing compounds.
30. A process according to claim 29 wherein said fluid is a coke quench medium.
31. A process according to claim 29 wherein said chemical adsorbents are SO_x

sorbents.

32. A process according to claim 19 further comprising using an excess capacity of said thermal cracking process to recycle at least one plastic, wherein the recycling process comprises the steps:
 - (a) Providing said at least one plastic;
 - (b) Pulverizing said at least one plastic to less than about 100 mesh; and
 - (c) Adding said at least one plastic to said thermal cracking process at a point with sufficient temperature to fluidize said at least one plastic and sufficient residence time to mix with other feed and achieve desired cracking temperature prior to a thermal cracking/coking reaction chamber.
33. A process according to claim 32 wherein said at least one plastic is added to said thermal cracking process in a feed recycle stream downstream of a fractionator.
34. A coke product made in accordance with a process according to claim 19.
35. A coke product according to claim 34 wherein said coke product is adapted for use as an adsorption media.
36. A coke product according to claim 35 wherein said coke product is adapted to be used for fuel after serving as said adsorption media.
37. A coke product according to claim 34 wherein said coke product is adapted for use as an adsorption media for adsorption and removal of at least one undesirable flue gas component from a combustion process.

38. A coke product according to claim 37 wherein said at least one undesirable flue gas component is selected from the group consisting of sulfur oxides, nitrogen oxides, carbon dioxide, dioxins, furans, mercury compounds, and other air toxics comprised of hydrocarbon or a metal compound.
39. A coke product according to claim 34 wherein the sulfur content of said coke product is adapted to enhance the adsorption of mercury and other metal compounds.
40. A coke product made in accordance with a process according to claim 22.
41. A coke product according to claim 40 wherein said coke product is adapted for use as an adsorption media.
42. A coke product according to claim 41 wherein said coke product is adapted to be used for fuel after serving as said adsorption media.
43. A coke product according to claim 40 wherein said coke product is adapted for use as an adsorption media for adsorption and removal of at least one undesirable flue gas component from a combustion process.
44. A coke product according to claim 43 wherein said at least one undesirable flue gas component is selected from the group consisting of sulfur oxides, nitrogen oxides, carbon dioxide, dioxins, furans, mercury compounds, and other air toxics comprised of hydrocarbon or a metal compound.
45. A coke product according to claim 40 wherein the sulfur content of said coke product is adapted to enhance the adsorption of mercury and other metal compounds.

46. A coke product made in accordance with a process according to claim 23.
47. A coke product according to claim 46 wherein said coke product is adapted for use as an adsorption media.
48. A coke product according to claim 47 wherein said coke product is adapted to be used for fuel after serving as said adsorption media.
49. A coke product according to claim 46 wherein said coke product is adapted for use as an adsorption media for adsorption and removal of at least one undesirable flue gas component from a combustion process.
50. A coke product according to claim 49 wherein said at least one undesirable flue gas component is selected from the group consisting of sulfur oxides, nitrogen oxides, carbon dioxide, dioxins, furans, mercury compounds, and other air toxics comprised of hydrocarbon or a metal compound.
51. A coke product according to claim 46 wherein the sulfur content of said coke product is adapted to enhance the adsorption of mercury and other metal compounds.
52. A coke product made in accordance with a process according to claim 25.
53. A coke product according to claim 52 wherein said coke product is adapted for use as an adsorption media.
54. A coke product according to claim 53 wherein said coke product is adapted to be used for fuel after serving as said adsorption media.

55. A coke product according to claim 52 wherein said coke product is adapted for use as an adsorption media for adsorption and removal of at least one undesirable flue gas component from a combustion process.
56. A coke product according to claim 55 wherein said at least one undesirable flue gas component is selected from the group consisting of sulfur oxides, nitrogen oxides, carbon dioxide, dioxins, furans, mercury compounds, and other air toxics comprised of hydrocarbon or a metal compound.
57. A coke product according to claim 52 wherein the sulfur content of said coke product is adapted to enhance the adsorption of mercury and other metal compounds.
58. A coke product according to claim 52 wherein the sulfur content of said coke product is sufficiently reduced to enable said coke product to be used for steel or aluminum manufacture.
59. A coke product made in accordance with a process according to claim 29.
60. A coke product according to claim 59 wherein said coke product is adapted for use as an adsorption media.
61. A coke product according to claim 60 wherein said coke product is adapted to be used for fuel after serving as said adsorption media.
62. A coke product according to claim 59 wherein said coke product is adapted for use as an adsorption media for adsorption and removal of at least one undesirable flue gas component from a combustion process.

63. A coke product according to claim 62 wherein said at least one undesirable flue gas component is selected from the group consisting of sulfur oxides, nitrogen oxides, carbon dioxide, dioxins, furans, mercury compounds, and other air toxics comprised of hydrocarbon or a metal compound.
64. A coke product according to claim 59 wherein the sulfur content of said coke product is adapted to enhance the adsorption of mercury and other metal compounds.
65. A coke product according to claim 59 wherein the sulfur content of said coke product is sufficiently reduced to enable said coke product to be used for steel or aluminum manufacture.
66. A coke product made in accordance with a process according to claim 32.
67. A coke product according to claim 66 wherein said coke product is adapted for use as an adsorption media.
68. A coke product according to claim 67 wherein said coke product is adapted to be used for fuel after serving as said adsorption media.
69. A coke product according to claim 66 wherein said coke product is adapted for use as an adsorption media for adsorption and removal of at least one undesirable flue gas component from a combustion process.
70. A coke product according to claim 69 wherein said at least one undesirable flue gas component is selected from the group consisting of sulfur oxides, nitrogen oxides, carbon dioxide, dioxins, furans, mercury compounds, and

other air toxics comprised of hydrocarbon or a metal compound.

71. A coke product according to claim 66 wherein the sulfur content of said coke product is adapted to enhance the adsorption of mercury and other metal compounds.
72. A coke product according to claim 66 wherein the sulfur content of said coke product is sufficiently reduced to enable said coke product to be used for steel or aluminum manufacture.
73. A method for producing energy, said method comprising combusting a fuel, said fuel comprising coke, said coke comprising essentially high porosity sponge coke and volatile combustible materials (VCMs) in amount in the range from about 13% to about 50% by weight.
74. A method according to claim 73 wherein said VCMs are present in an amount in the range of from about 15% to about 30% by weight.
75. A method for producing energy according to claim 73 wherein said fuel comprises a mixture of said coke and at least one other fuel, and wherein the heat release ratio of said coke to said at least one other fuel in said mixture is greater than about 1:4.
76. A method according to claim 75 wherein said at least one other fuel is coal, fuel oil, natural gas, by-products, or wastes.
77. A process according to claim 2 wherein said sodium levels are reduced to less than about 5 ppm by weight.

78. A process according to claim 1 wherein said coke product is comprised of sponge coke in an amount in the range of about 60% to 100% by weight.
79. A method according to claim 10 wherein said coke has sodium present in an amount less than about 25 ppm by weight.
80. A method according to claim 10 wherein said coke comprises sponge coke in an amount in the range of about 60% to 100% by weight.
81. A coke comprising sponge coke in an amount in the range of about 40% to 100% by weight, said coke having volatile combustible material (VCM) present in an amount in the range of from about 13% to about 50% by weight.
82. A coke according to claim 81 wherein said sponge coke is in an amount of about 60% to 100% by weight.
83. A coke according to claim 81 wherein said volatile combustible material (VCM) is present in an amount in the range of from about 15% to about 30% by weight.
84. A coke according to claim 81 wherein said coke has sodium present in an amount less than about 25 ppm by weight.
85. A process according to claim 1 wherein said thermal cracking process includes adding predetermined hydrocarbon compounds to promote an increase of the VCM content of said coke product to within the range of from about 13% to about 50% by weight.
86. A process according to claim 1 further comprising adding predetermined